Dual Axis Solar Tracking System Using LDR Sensors

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Abstract - *In this paper a microcontroller is used for dual axis solar tracking system. As the world population increases tremendously, the demand of power also increases hence in future there may be chance of power crisis. To avoid the power crisis to some extend renewable sources are preferred i.e. Solar energy. In this accurate working of dual axis solar tracking system is presented. The dual axis solar tracking system controls elevation and orientation angle of solar panel such that the panel always maintain perpendicular to the straight. The results indicated that dual axis solar tracking system is having low cost, reliable and efficient and it has an overall efficiency of 8% to 25% more than the fix angle tracking system*

Key Words: Dual axis solar tracking, Efficiency, Orientation angle, Panel

1. INTRODUCTION

Today's world requires more and more energy every day, which is against the continuous reduction of existing fossil fuel resources and the growing concern about environmental pollution. Therefore, it is obvious that this has pushed humanity to explore new technologies for the production of electricity, using clean and renewable sources such as solar and wind energy.

An important source of renewable energy is solar energy, which offers a great possibility of conversion into electricity, which in turn guarantees an important part of the energy needs of the plant.

Photovoltaic energy (PV Cell) is the conversion principle used in converting sunlight into electricity. Using the solar tracking technique, solar panel performance can be increased by 30%, unlike 60% of fixed installations.

A solar tracking device has a wide range of applications to improve the use of solar insulation. Therefore, the problem is to implement a system capable of improving the production of solar energy by 30% - 40%. A microcontroller is used to implement the control circuit which is the turning position and a motor used to orient the solar panel optimally. The goal of these systems is that the sun beam that falls perpendicular to the solar panel provides the maximum solar energy that is used to generate electricity with maximum energy between 12.00 and 14.00 and the maximum around noon. When the sun is almost directly on the solar panel and the minimum energy is used to move the solar panel, which further increases the efficiency of the tracker.

1.1 CONCEPTS ON SOLAR RADIATION

The sun, at an estimated temperature of 5800 ° k, emits a large amount of energy in the form of radiation, which reaches the planet of the solar system. Sunlight has two components: the direct beam and the diffused ray. Direct radiation (also called beam radiation) is the solar radiation of the sun which are not dispersed (due to shade). The direct beam carries around 90% of the solar energy and the "diffused sunlight" that carries the rest. The diffuse part is the blue sky on a clear day and increases as a part in cloudy days, the scattered radiation is the solar radiation that has been dispersed (complete radiation on cloudy days). The reflected radiation is the incident radiation (beam and diffuse) that has been reflected from the earth. The sum of the scattered and reflected beam radiation is considered as the global radiation on a surface. Because most of the energy is in the direct range. Maximizing the collection requires the sun to be visible to the panels for as long as possible

1.2 NEED OF SOLAR TRACKER

The energy brought by the direct beam falls with the cosine of the angle between the incoming light and the panel. Table no.1.2 shows the lost direct power (%) due to the misalignment (angle i).

Table no-1.2: Direct power lost (%) due to misalignment (angle i)

Misalignment (angle *i*)	Direct power lost (%)= 1- cos(i)
0°	0
1°	0.015
3°	0.14
8°	1
23.4°	8.3
30°	13.4
45°	30
75°	>75

The sun travels 360 degrees from east to west per day, but in the perspective of any fixed position, the visible portion is 180 degrees during a half-day period. The effects of the local horizon are slightly reduced, causing an effective movement of around 150 degrees.

A fixed-orientation solar panel between sunrise and sunset ends will see a 75-degree movement on each side and, therefore, according to the table above, you will lose 75% of the energy in the morning and at night. Turning the east and west panels can help recover these losses. A tracker classification in the east-west direction is known as single-axis tracking.

The sun also shifts the through 46 degrees north-south during the period of one year. The same group of panels located at the intermediate point between the two local ends will see how the sun moves 23 degrees on each side, causing losses of 8.3%. A tracker that counts both for daily movement and seasoned motion called a double-axis tracker.

1.2. TYPES OF SOLAR TRACKER

Mainly there are two types of solar tracker such as:

1) Passive Tracking System
2) Active Tracking System

1) Passive Tracking System

The passive tracking system performs the movement of the current using a low boiling liquid. This liquid is vaporized due to the adding heat of the sun and the center of mass moves so that the system finds the new equilibrium position.

2) Active Tracking System

The two basic types of active solar tracker are single-axis tracker and double-shaft tracker.

a) Single Axis Tracker

The single axis tracking system performs the elevation or azimuth movement for a solar energy system, which of these movements is desired depends on the technology used in the tracker and the space in which it is mounted. For example, the parabolic system uses azimuth tracking, while many roof photovoltaic system uses elevation detection due to lack of space. A single-axis tracker can only rotate at a point both horizontally and vertically. This makes it less complicated and generally cheaper than a two-axis tracker, but also less effective in collecting the total solar energy available at a site. The tracker uses motors and gears to direct the locator as ordered by a controller that responds to the solar direction. Since the engine consumes energy, it is necessary to used it when required. The mono axial tracker has a degree of freedom that acts as a rotation axis. There are several common implementations of the single-axis tracker. A horizontal axis tracker consists of a long horizontal tube to which the solar modules are connected. The tube is aligned in a north-south direction, is supported by a bearing mounted on frame and rotates slowly on its axis to follow the movement of suns in the sky. This type of tracker is more effective in the equatorial latitudes where the sun is more or less above midday. In general, it is effective when the solar path is high in the sky during the substantial parts of the year, but for the same reason, it does not work well at high latitudes. For higher latitudes, a vertical axis tracker is more suitable. It works well anywhere the sun is typically lower in the sky and, at least in the summer months, the days are long.

b) Double-Axis Tracker

Dual-axis tracker has two degrees of freedom that act as axes of rotation. The dual-axis solar tracker, as suggested by the same, can rotate simultaneously in the horizontal and vertical direction and, therefore, can accurately point the sun at any time and in any position. The dual axis tracking systems perform the movements along the elevation and azimuth axes. These tracking systems naturally offer the best pre-processing, as the component also has a sufficiently high accuracy.

2. THE HARDWARE SYSTEM

A general block diagram of the system is shown in fig. 2. The hardware system consists of various components. The functions of each components of the system are described as follows:

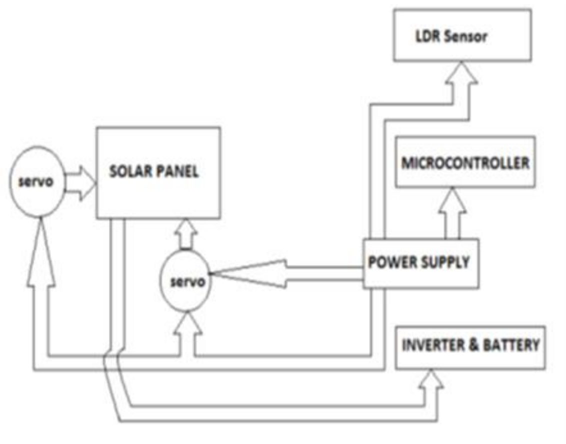

Fig.2: - Block Diagram

2.1 SENSOR

In this system we use five light-dependent resistors (LDRs) as sensors. They perceive the area with the highest density of sunlight. The solar panel moves to the high-density area of light through the servomotors. Each LDR is connected to the power supply that forms a potential splitter. Therefore, any variation in light density is proportional to the voltage variation in the LDR shown in fig. 2.1.

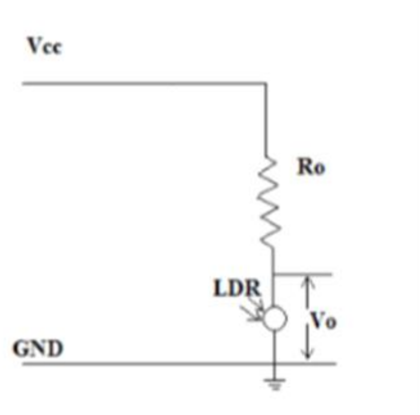

Fig: - 2.1. Sensor

LDR is a passive transducer, so there is used of the potential divider circuit to get the corresponding voltage value of the LDR resistor. The LDR resistance is inversely proportional to the intensity of the light that falls on it i.e. to a greater intensity or luminosity of light, lower resistance and vice versa.

2.2 MICRO-CONTROLLER

The ATMEGA-168 is an 8-bit single-chip microcontroller of the modified Harvard architecture developed by Atmel. It uses flash memory in the program storage chip, unlike the programmable ROM of a single use, the EPROM or EEPROM that other microcontrollers use at that time. Fig. 2.2 shows pin diagram of atmega-168.

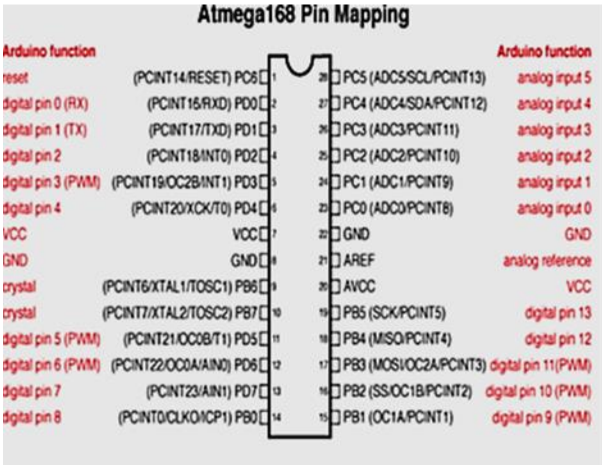

Fig: - 2.2 Micro-Controller

2.3 DC SERVOMOTOR

By itself, the standard DC motor is not an acceptable method for controlling a solar tracking matrix. This is due to the fact that DC motors are free and therefore, difficult for accurate position. Even if the synchronization to start and stop the engine is correct, the armature does not stop immediately, the DC motor has very gradual acceleration and deceleration curves, so the stabilization is slow. Adding gears to the engine will help to reduce this problem, but the excess is still present and will eliminate the initial stopping position. The only way to effectively use a DC motor for precise positioning is to use a servo. The servomotor is actually a set of four things: a normal DC motor, a reducer, a position detection device (usually a potentiometer) and a control circuit. The servo function is to receive a control signal that represents the desired output of the servo axis and apply power to the DC motor until its axis is in that position. Use the position detection device to determine the rotation position of the shaft, so it is knowing that how the motor should rotate to move the axis to the drive position. The solar panel connected to the engine will react according to the direction of the engine.

2.4 BATTERY

The battery is a series of electrochemical cells for the storage of electricity, connected individually and housed in a single unit. An electric battery is a device made up of one or more electrochemical cells that convert the stored chemical energy into electrical energy. Each cell contains a positive terminal, or cathode, and a negative terminal or anode. The electrolytes allow the ions to move between the electrodes and the terminals, allowing the current to flow from the battery to carry out the work. Lead-acid batteries are the most common in photovoltaic systems because their initial cost is lower and because they are available almost anywhere in the world. There are different sizes and designs of lead-acid batteries, but the most important designation is that they are deep-cycle batteries. Lead-acid batteries are available both in the wet cell (maintenance required) and in the sealed version without maintenance. Lead acid batteries are reliable and affordable with exceptional durability. Lead acid batteries are highly reliable due to their ability to withstand overload and vibration. The use of special sealing techniques ensures that our batteries are leak-proof and do not ruin. The batteries have an exceptional load acceptance, a large volume of electrolyte and a low self-discharge, making them ideal as low maintenance lead-free batteries. The batteries are manufactured tested using CAD (Computer Aided Design). These batteries are used in inverter and UPS systems and have the proven ability to operate in extreme conditions. The batteries have a volume of electrolyte, use PE (Potential Energy) separators and are sealed in sturdy containers, which provide excellent protection against leakage and corrosion.

2.5 SOLAR PANEL

In this system, a monocrystalline photovoltaic solar panel (m-Si) is used, chosen for its good efficiency, lower installation cost, built-in energy. The monocrystalline photovoltaic solar panels are not dangerous for the environment, greater heat resistance and increased electrical generation. This 10 W solar panel is a combination of a solar cell that generates a maximum of 10 W of electricity when exposed to sunlight. Leaves from 2 V to 20 V depending on the intensity of sunlight and comes with two cables finished with crocodile clips (black and red). With a medium size (78 mm × 26 mm) and a light weight (1.2 kg), it is suitable for a variety of applications.

3. WORKING

The main aim of the dual axis solar tracking system is to track the sun position and collect the maximum amount of solar energy to obtained the maximum output. In order to track the solar radiation very accurately. In the dual axis solar tracking system LDR sensors i.e. light resistance sensors are used and to store the amount of energy produce by solar panel which is converted into electrical battery for used. When sunrise occurs at that time the position of sun is at east i.e. horizontal to the solar tracking system. Hence the LDR sense the accurate position of sun by using solar radiation and gives signal to the microcontroller. By receiving signal from LDR microcontroller produces signal to adjust the positioning of the motor such that it can perpendicular to the direction of solar radiation. The dual axis solar tracking system always take care of the position of solar panel such that they always perpendicular to the direction of incident radiation i.e. photons. As these radiation falls on the solar panel i.e. photovoltaic cells and energy produced is stored in the battery for the further used. Inverter circuit is also used to covert DC supply into AC supply.

4. CONCLUSION

In this paper, dual axis tracker system perfectly aligns with the sun direction and tracks the sun movement in more efficient way is presented. The results show that dual axis tracking system is superior than the single axis solar tracking system. Power captured by dual axis solar tracking system is high during the whole time period and it maximize the conversion of solar radiation into electrical energy output. The system is cost effective, reliable and efficient. From this paper, it is concluded that dual axis solar tracking system has an increased energy of about 17%-25% more than the fixed angle system.

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